Experiment 1: Parametric Curves

CZ2003 Computer Graphics and Visualization

SS3

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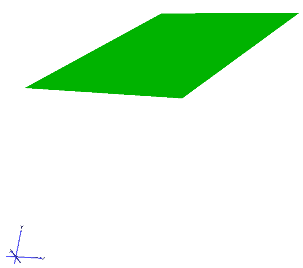
Contents

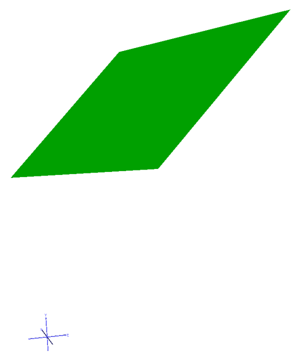
1 DEFINING SURFACES PARAMETRICALLY

1.1 Plane Passing Through Three Defined Points

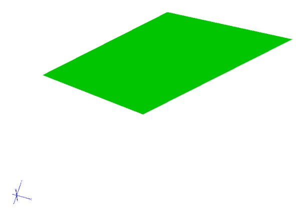
To define the plane parametrically, we can use the following formula: $P = P1 + u(P2 - P1) + v(P3 - P1)$
Therefore, with the 3 points $(N, M, 0),\ (0, M, N),\ (N, 0, M)$, we get:
$x(u, v) = N - Nu = \mathbf{8 - 8u}$
$y(u, v) = M + Mv = \mathbf{10 + 10v}$
$z(u, v) = Nu + Mv = \mathbf{8u + 10v}$
$\mathbf{u, v \in [0, 1]}$



(a) Resolution: 1 1



(b) Resolution: 10 10



(c) Resolution: 1000 1000

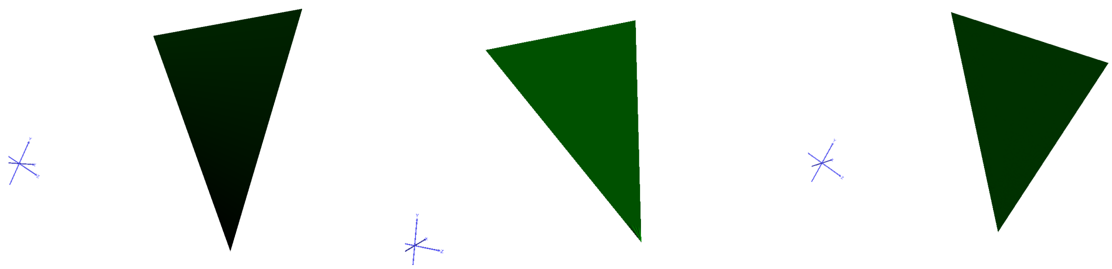
Fig. 1. Plots of the plane defined in "**1a.wrl**" with differing resolutions

As seen in Fig. 1 above, a sampling resolution of **1** for both u and v is sufficient for drawing the plane as it has no curvature and having a higher resolution would produce the exact same drawing.

1.2 Triangular Polygon with Three Defined Vertices

To define the Triangular Polygon, we use the formula for defining Bilinear Surface Parametrically, and we set two of the points to be the same point, essentially resulting in a Triangular polygon.

$P = P1 + u(P2 - P1) + v(P3 - P1 + u(P4 - P3 - (P2 - P1)))$
Let P4 = P3, we get:
$P = P1 + u(P2 - P1) + v(P3 - P1) + uv(P1 - P2)$
Therefore, with the 3 points $(N, M, 0),\ (0, M, N),\ (N, 0, M)$, we get:
$x(u, v) = N - Nu + Nuv = \mathbf{8 - 8u + 8uv}$
$y(u, v) = M - Mv = \mathbf{10 - 10v}$
$z(u, v) = Nu + Mv - Nuv = \mathbf{8u + 10v - 8uv}$
$\mathbf{u, v \in [0, 1]}$



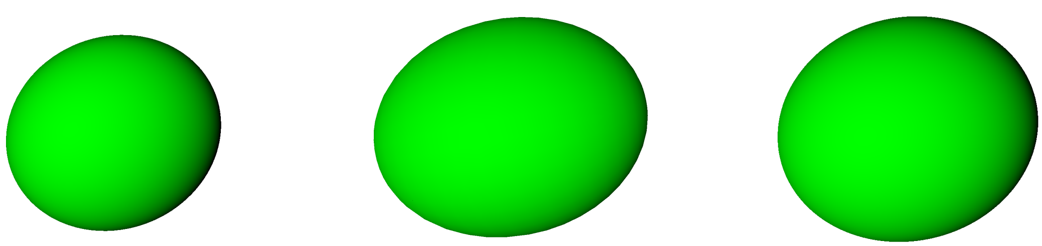
(a) Resolution: 1 1
(b) Resolution: 10 10
(c) Resolution: 1000 1000

Fig. 2. Plots of the Triangular Polygon defined in "**1b.wrl**" with differing resolutions

As seen in Fig. 2 above, a sampling resolution of **1** for both u and v is sufficient for drawing the triangular polygon as it has no curvature and having a higher resolution would produce the exact same drawing.

1.3 Origin-Centered Ellipsold with Defined Semi-axes

An elipsoid can be parametrically defined using the following functions:
$x = acos(u)sin(v)$
$y = bsin(u)$
$z = ccos(u)cos(v)$
Where $u \in [-\pi/2, \pi/2]$ and $v \in [-\pi, \pi]$. Therefore, we can get:
$x = Ncos(-\pi/2 + \pi u)sin(-\pi + 2\pi v) = \mathbf{8cos(-\pi/2 + \pi u)sin(-\pi + 2\pi v)}$
$y = Msin(-\pi/2 + \pi u) = \mathbf{10sin(-\pi/2 + \pi u)}$
$z = (N + M/2)cos(-\pi/2 + \pi u)cos(-\pi + 2\pi v) = \mathbf{9cos(-\pi/2 + \pi u)cos(-\pi + 2\pi v)}$
$u, v \in [0, 1]$



(a) Resolution: 50 100
(b) Resolution: 25 50
(c) Resolution: 100 200

Fig. 3. Plots of the Triangular Polygon defined in "**1c.wrl**" with differing resolutions

The sampling resolution for v is chosen to be 2 times larger than that of u as the coefficient of v is 2 times larger. As seen in Fig. 3 above, the best resolution obtained was 50, 100 for u and v respectively. By decreasing the resolution to 25 and 50, the interpolations could be seen when zoomed in. When the resolution was increased instead to 100 and 200, no visible difference could be seen.